TARGETS: A NUMBER GAME
TABLE OF CONTENTS

Introduction..... 1

Objectives..... 4

Program Description..... 5
- How to Play..... 5
- The Championship Game..... 8
- Change Option.....11

Suggestions for Classroom Use.....12

Apple: Working with the Computer.....13

Atari: Working with the Computer.....14

TRS-80: Working with the Computer.....15

"What Happens If...?" Sunburst Courseware and Warranty.....16

Here's a sample problem. Use the numbers 5 and 6 (any amount of 5's and 6's that you need) to add up to 35. Easy. 5+5+5+5+5+5+5. But here's another way: 5+6+6+6+6+6. Is there a third way?

In playing TARGETS, children can choose the target (any number from 0 to 99) and the computer chooses the two numbers (like 5 and 6 in the example above) or the player can choose the two numbers (from 1 to 9) and the computer chooses the target.

Suppose the target were 27 and the numbers 5 and 6. This time you may have to think hard. How about 5+5+5+6+6? Is there another way?

Now suppose the numbers are 5 and 6 and the target 9. If only addition is allowed, there is no way to hit the target. Some problems in TARGETS are impossible, some very transparent, and some require a great deal of complex thinking.

In Level 1, only addition is allowed.

In Level 2, both addition and subtraction are allowed. Can you use 3 and 5 to make 1? How about 3+3-5? Is there another way? How about using 3 and 6 to make 1? Impossible! Only multiples of three are possible with 3 and 6.

In Level 3, all four operations--addition, subtraction, multiplication and division are allowed. In Level 3, all targets are possible. For example, suppose the two numbers are 4 and 6 and the target 31. There are easier ways to get 31, but one could add thirty-one 6's and then divide by 6.

In Level 3, an issue of major algebraic importance arises. What is 6+3x5? Working from left to right, one could add the 6 and 3, then multiply by 5. This result is 45. But one could also see the 3 x 5 as 15, then add the 15 to 6 to get 21. Which is right? Both are. The situation is totally ambiguous. To clarify the issue, mathematicians have introduced a convention--do the operation in parentheses first. Then (6+3)x5 is 45 and 6+(3x5) is 21. In TARGETS, parentheses are automatically entered by the computer in complex Level 3 "equations." The computer always adds parentheses in a sequential order. That is, it places parentheses around the quantities preceeding any multiplication or division sign, for example: ((3+1)x3+1)÷3.

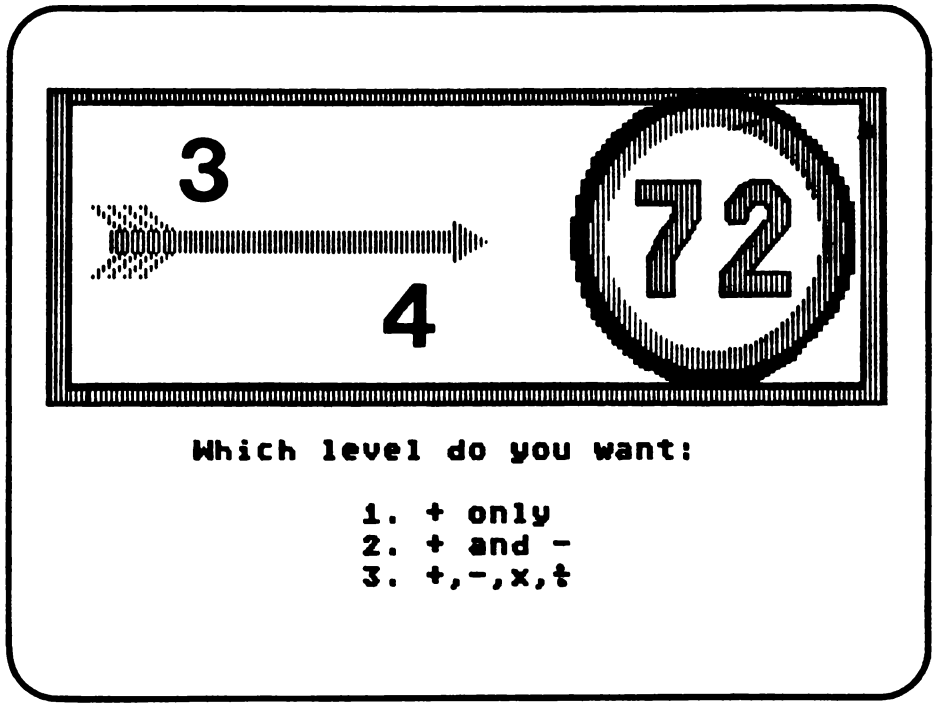
At each level in TARGETS, players play a first round where they can choose the target or the numbers. Then if they succeed, they can play a Championship Game. If they use fewer steps then the Champion, their name and score and "equation" are stored by the computer for others to challenge.

In general, TARGETS enables players to think mathematically in problem solving situations involving numbers. Certainly children will learn a great deal about numbers and about the four operations (and gets lots of practice in arithmetic while doing so), but TARGETS goes far beyond narrow computational skills. What TARGETS does is enable children:

- to construct and test hypotheses,
- to think combinatorially,
- to make decisions about pathways to a goal (and to choose the simplest from several such pathways),
- to distinguish between possible and impossible, and,
- perhaps most important, to see mathematics as thought and action rather than as a bunch of a static magic unconnected facts and recipes.

As Polya says, mathematics is not a spectator sport.

TARGETS: A NUMBER GAME



Prerequisite Skills: addition, subtraction, multiplication and division of numbers up to 99.

Students Work With: addition, subtraction, multiplication, division, logic

Grade Level: 3 - adult

Reading Level: 3rd grade

Time Required: 5 minutes per game

Objectives:

1. to practice basic operations
2. to invent the most efficient solution to a problem
3. to construct and test hypotheses
4. to think combinatorially
5. to distinguish the possible from the impossible

PROGRAM DESCRIPTION

TARGETS: A NUMBER GAME uses basic numerical operations to develop problem solving skills.

The game involves

1. a pair of numbers from 1-9,
2. the operation(s) to be used with the numbers, and
3. a target number from 0-99.

Students must combine the two numbers using the operation(s) to arrive at the target number.

There are three levels of play. In the first level, students add any combination of the two numbers to reach the designated target. Level 2 lets students use addition and/or subtraction. In the third level, students work with addition, subtraction, multiplication and division to reach their target.

Students have the option of choosing either the numbers or the target. If they choose the two numbers, the computer will randomly select the target. If they choose the target, the computer selects the two numbers.

Once students have succeeded at a level, they can play a Championship Game. The computer has 30 Championship Games stored for each level. One of those games is randomly chosen determining the numbers and the target the students may use. The students try to reach the given target number in the smallest number of steps. If they beat the current champion, their name and solution is recorded.

How to Play

In the beginning of the program, students are given instructions on how to play. Students are then asked:

> Which level do you want:
>
> 1. + only
> 2. + and -
> 3. +, -, x, ÷
>
> Enter 1, 2 or 3:

Students should begin playing TARGETS on the first level.

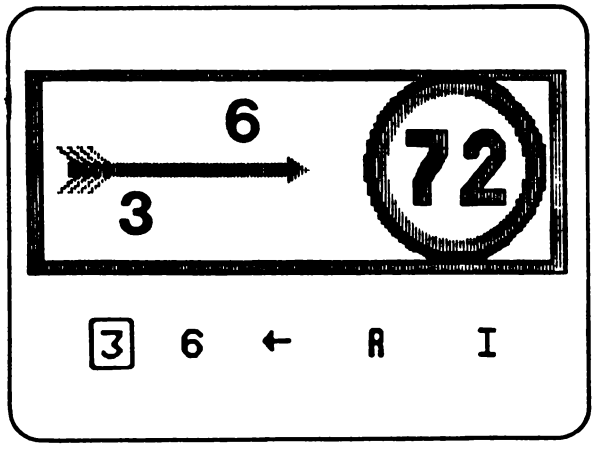
Students then choose if they want to select the numbers or the target. If the students want to select the numbers, they will be asked to:

> Enter a number (1 to 9):
>
> Enter a different number (1 to 9):

If they want to select the target, they will be asked to:

Enter a target number from 0 to 99:

If students enter the numbers, the computer will choose the target. If they choose the target, the computer will select two numbers.



The target is then displayed on the top of the screen as shown above. The numbers the students work with are listed on the bottom of the screen along with:

← Erases the last number or sign entered.

R Restart. Erases the student's solution to this point and starts over.

I Impossible. The solution is not possible with the numbers selected and operations allowed.

Students move the selection box using the < or > keys on the Atari or the ← or → keys on the Apple or TRS-80 until it shows the response they want and then press RETURN or ENTER. A new set of options will appear which include the allowable operations (depending on the level) and:

→ Erases the last number or sign entered.

R Restart. Erases the entire answer to this point and starts over.

I Impossible. The problem is not possible with the numbers selected and operations allowed.

The students continue to choose numbers and operations until they reach their target. The number of steps and their current total is displayed and updated on the screen. (Students are restricted from totals more than 100,000.)

Students may use up to 50 steps on the Atari or 32 steps on the TRS-80 to reach a target. However, efficiency is one objective of TARGETS. Students should be encouraged to reach their target in the smallest number of steps.

Reaching the Target

Once students reach the target, the computer automatically prints:

You reached the target!!!

The students then choose from:

1. Play the same game
2. Play a different game
3. Play a Championship Game
4. Choose a different level
5. End

1. Play the same game

If students choose option 1, they will be given the same variables used in the last game (the same numbers, target and operation(s)). Thus, they can try to improve on their previous play.

2. Play a different game

Selecting option 2 lets the student choose a different target or different numbers keeping the operation(s) the same as the last game.

3. Play a Championship Game

If option 3 is selected, the screen will show the student who holds the record for the Championship Game and the number of steps taken. Students try to set a new record (see page 8 for more information).

4. Choose a different level

If students select the last option, students are returned to the menu:

Which level do you want?

1. + only
2. + and -
3. +, -, x, ÷

Enter 1, 2 or 3:

Stopping

At any time, students may stop by holding the CONTROL key and pressing the E key on the Atari or by holding Shift key and down-arrow key while pressing the E key on the TRS-80. This will bring them to:

1. Play the same game
2. Play a different game
3. Choose a different level
4. End

The End option will allow them to insert a new diskette or turn off the computer.

The Championship Game

At each level, 30 championship games are available. When students select the Championship Game, one of the games is randomly chosen. The Championship Games are devised to provoke complex thinking by the students.

The Championship Games consist of two or three numbers and a target. If students have been playing Level 1 games, they will receive Level 1 problems. The same is true of Levels 2 and 3.

If students complete the Championship Game in fewer steps than the existing record, their name, number of steps, and solution will be recorded in the computer. The teacher can monitor these scores through the Change Option (see page 11).

If students complete the problem in more steps or an equal number of steps, they will not be named the new champion. The champion's score and solution will be displayed. If the teacher does not wish the solution to be shown, it can be turned off in the Change Option (see page 11).

LEVEL 1

LEVEL GAMES	NUMBERS			TARGET	MINIMUM STEPS
Game 1	9	7		56	Steps= 8
Game 2	1	6		25	Steps= 5
Game 3	1	3	9	17	Steps= 5
Game 4	2	5	9	23	Steps= 3
Game 5	2	5	9	38	Steps= 5
Game 6	2	3	8	40	Steps= 5
Game 7	2	7	8	41	Steps= 6
Game 8	3	5	8	33	Steps= 6
Game 9	3	6	8	72	Steps= 9
Game 10	3	8	4	60	Steps= 8
Game 11	4	5		62	Steps= 13
Game 12	4	8		72	Steps= 9
Game 13	5	6	3	51	Steps= 9
Game 14	5	7	3	24	Steps= 4
Game 15	6	7	3	50	Steps= 8
Game 16	6	8	3	66	Steps= 9
Game 17	7	8	3	37	Steps= 5
Game 18	7	9	3	78	Steps= 10
Game 19	8	9	3	80	Steps= 9
Game 20	5	8	7	58	Steps= 8
Game 21	2	3		22	Steps= 8
Game 22	3	7		24	Steps= 4
Game 23	3	8		38	Steps= 6
Game 24	4	5		49	Steps= 10
Game 25	4	7		36	Steps= 6
Game 26	5	7		45	Steps= 7
Game 27	5	8		40	Steps= 5
Game 28	6	7		33	Steps= 5
Game 29	7	9		32	Steps= 4
Game 30	8	9		51	Steps= 6

LEVEL 2

LEVEL GAMES	NUMBERS			TARGET	MINIMUM STEPS
Game 1	1	5	3	14	Steps= 4
Game 2	1	7	8	68	Steps= 9
Game 3	2	3		13	Steps= 5
Game 4	2	5	4	52	Steps= 11
Game 5	2	9		41	Steps= 7
Game 6	3	5	1	27	Steps= 7
Game 7	3	8		4	Steps= 5
Game 8	3	8	9	24	Steps= 3
Game 9	4	7		10	Steps= 3
Game 10	4	9		2	Steps= 6
Game 11	5	6	7	88	Steps= 13
Game 12	5	7		11	Steps= 5
Game 13	5	9		1	Steps= 3
Game 14	5	9		3	Steps= 5

(Level 2 cont'd.)

Game 15	6	7	8	22	Steps= 3
Game 16	6	8	9	4	Steps= 4
Game 17	7	9		4	Steps= 4
Game 18	7	8	3	25	Steps= 4
Game 19	3	5		37	Steps= 9
Game 20	8	1	4	43	Steps= 7
Game 21	2	4		48	Steps= 12
Game 22	2	5		4	Steps= 2
Game 23	2	7		10	Steps= 4
Game 24	3	5		22	Steps= 6
Game 25	3	7		11	Steps= 3
Game 26	4	7		9	Steps= 5
Game 27	5	8		1	Steps= 5
Game 28	6	8		42	Steps= 6
Game 29	7	8		29	Steps= 4
Game 30	8	9		12	Steps= 7

LEVEL 3

LEVEL GAMES	NUMBERS			TARGET	MINIMUM STEPS
Game 1	3	5	4	14	Steps= 3
Game 2	1	6	5	12	Steps= 2
Game 3	9	8	6	71	Steps= 4
Game 4	5	8	7	6	Steps= 3
Game 5	5	9	8	48	Steps= 3
Game 6	1	3	4	48	Steps= 3
Game 7	1	5		20	Steps= 3
Game 8	3	4		13	Steps= 3
Game 9	3	4	5	22	Steps= 3
Game 10	3	7	4	44	Steps= 3
Game 11	3	9	8	28	Steps= 4
Game 12	4	9	5	77	Steps= 3
Game 13	5	9	3	33	Steps= 4
Game 14	6	7	8	67	Steps= 5
Game 15	7	8		4	Steps= 5
Game 16	6	8	3	10	Steps= 3
Game 17	8	9		51	Steps= 6
Game 18	8	3	4	64	Steps= 2
Game 19	3	4		81	Steps= 4
Game 20	1	4		65	Steps= 4
Game 21	2	3		80	Steps= 6
Game 22	3	7		2	Steps= 3
Game 23	3	8		61	Steps= 3
Game 24	4	7		30	Steps= 4
Game 25	4	9		2	Steps= 3
Game 26	5	6		66	Steps= 3
Game 27	5	9		56	Steps= 5
Game 28	2	6		17	Steps= 4
Game 29	6	9		80	Steps= 5
Game 30	8	9		74	Steps= 5

CHANGE OPTION

To access the Change Option, press a CONTROL T on the Atari or the Shift key, down-arrow and the T key on the TRS-80. The Change Option can be accessed at the level menu or the option where you decide to play again, play a new different game, a Championship Game, or choose a different level.

The teacher will be given these options:

1) View Champions/Change Name
2) Reset Scores
3) Display Solutions
4) Return to Targets

View Champions/Change Name

The view option allows the teacher to see the name of the student holding the record for a given game at a given level and the number of steps used. A star or dot is placed in front of the student's name if the number of steps taken is the smallest possible. The teacher is then asked "Do you want to change a name?" If yes, the number of the name to change and the name are entered. If no, scores at the next level will be printed. A CONTROL E (or Shift, down-arrow, E) will bring you back to the list of change options.

Reset Scores

The reset option allows the teacher to delete all the names and delete the names from any level. This could be used at the end of a quarter or the end of the year.

Please note: Resetting on the Atari may take up to ten minutes so plan accordingly.

Display Solutions

The teacher has the option to suppress the printing of the champion's solution when another student does not beat the champion. Students can gain knowledge by looking at another student's solution. But if the teacher feels their students will want to copy the solutions, this option may be turned off by answering NO to the question "Should the students see the answer?" If the teacher has typed "NO," after students complete a Championship Game and do not beat the champion, they will be given only the champion's name and number of steps.